Butterfly Diagrams and Solar Minimum

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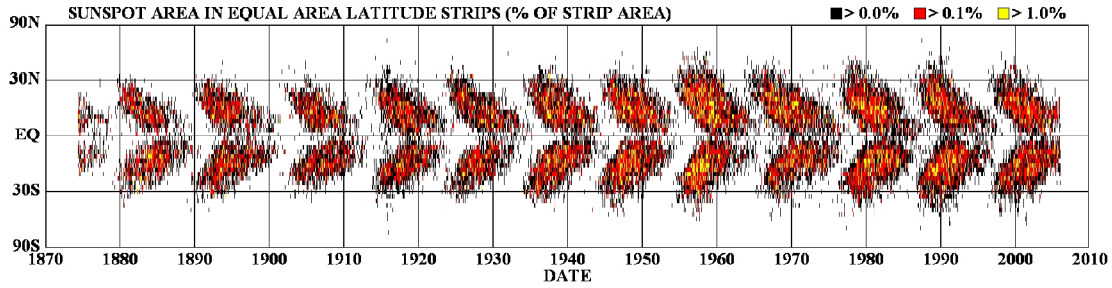
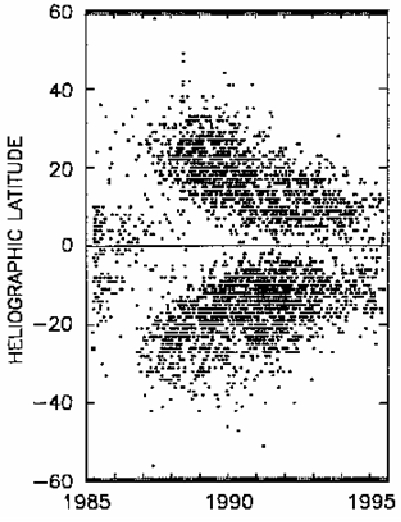
When sunspots appear at the beginning of a new solar cycle, they appear at the higher solar latitudes – from about 20^o to 40^o. As a solar cycle progresses, the sunspots appear at ever-lower latitudes, eventually ending up near the equator. If one plots the latitude of the sunspot versus time over many solar cycles, one ends up with the following plot (from www.nasa.gov/lb/vision/universe/solarsystem/solar_cycle_graphics_prt.htm).



The combination of data points in both the northern and southern hemispheres produces the look of the wings of a butterfly and hence the name of the plot – a butterfly diagram.

Note that most sunspots are grouped nicely in the wings. But also note what happens during the period of low solar activity. To better see this, let's zoom in on the data starting with the end of Cycle 21.

During 1985, 1986, 1987, and even into 1988 sunspots showed up at both high and low latitudes – and everywhere in between. There are two important facts about solar cycles related to this. First, solar cycles overlap. During the period of extremely low solar activity both "old" sunspots and "new" sunspots occur. This means the first sunspot of a new cycle usually occurs before the point in time we define as the end of one cycle and the start of the next (we call this "solar minimum", and it can be tough to determine because of this overlap). Second, latitude isn't a sure-fire indicator of which cycle a sunspot belongs to. To be certain, one also needs to know the magnetic polarity of the sunspot (sunspots of the new cycle are of opposite polarity from sunspots of the old cycle).



The fact that a sunspot from the new cycle occurs before the point in time we call solar minimum raises an interesting question. Can we estimate when solar minimum will occur based on when the first sunspot of a new cycle occurs? There is data in the scientific community that allows us to estimate this, but it is highly variable from cycle to cycle. Previous cycles have reached solar minimum anywhere from a half a year or so after the first new sunspot to many, many months after the first new sunspot.

So have we seen the first sunspot of Cycle 24? It appears that we may be on the verge of seeing it. A region of knotted magnetic fields rotated into view last week, and was reported to be at high latitude and of the proper magnetic polarity. If a sunspot comes out of it, then it looks like Cycle 24 has started – of course it will still be at least a couple years until we see some consistent F_2 region openings on 10m. More good news is the fact that the prediction of solar minimum by the International Space Environment Service now falls in line with the prediction of solar minimum by the Solar Cycle 24 Prediction Panel – around March 2008 (plus or minus several months).